Marine Physical Laboratory

Predator/Prey Relationships Between Phytoplankton and Zooplankton

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This project studies the fundamental relationships between predator macrozooplankton (i.e. euphausiids and copepods) and prey (i.e. phytoplankton) and their inter-relationship via a combination of optical serial sectioning and acoustic tracking. This program is an augmentation of our other ocean optics support from ONR and is aimed at making a practical realizable system to measure multispectral image scatter from underwater serial section images.

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Abstract

This project studies the fundamental relationships between predator macrozooplankton (i.e. euphausiids and copepods) and prey (i.e. phytoplankton) and their inter-relationship via a combination of optical serial sectioning and acoustic tracking. This program is an augmentation of our other ocean optics support from ONR and is aimed at making a practical realizable system to measure multispectral image scatter from underwater serial section images.

Scientific Objectives

Our objectives are to quantify the microscale and fine-scale vertical and horizontal patchiness of phytoplankton and large (.5 cm and up) zooplankton in situ. This includes knowledge of the 3-d statistics of the patchiness of phytoplankton and zooplankton on scales <1 km, to a resolution of centimeters, and their relation to the ambient physical environment. We are also interested in the correlation of zooplankton with phytoplankton patches and the dynamic response of zooplankton to phytoplankton patches under a variety of conditions.

Approach

We have proposed to address these scientific questions via a combination of data collection, analysis and modeling. Two instruments that have been recently developed in Dr. Jaffe's lab are an optical system for measuring Chl-a microstructure (OSST) and a high-frequency sonar imaging system for looking at zooplankton densities in 3-d (FishTV). Specifically, we planned in both years of this project to take both systems (sonar and optical) out to sea and deploy them in both a vertical profiling mode and at a fixed depth. In addition to the two systems, we planned to deploy a fluorometer and CTD package. The cruise plan was to go out to an area 5 -10 km due west of SIO and locate the subsurface Chl-a maximum using both the fluorometer and also the optical mapping system. The instruments would then be positioned in this maximum and pointed into the current (upstream) so as not to disturb the small-scale structure of the water. *In-situ* bottle samples of phytoplankton will be used to "ground truth" the fluorescence measurements. The results of the experiments will then be analyzed for coincident occurrences of both Chl-a maxima and acoustic backscatter. Intensity and variability of the signals will be analyzed to attempt to infer the densities of both phytoplankton and zooplankton, and the response of the zooplankton to the phytoplankton distribution. Results of models of the zooplankton behavior which incorporate the small-scale, observed phytoplankton distribution will be compared with the experimentally measured zooplankton densities to gain insights into the strategies that the animals may use to find food.

Tasks Completed

During the summer of July '95, our cruise was extremely successful: we were able to obtain good data from the OSST system in conjunction with the FishTV sonar. This was the first experimental deployment of the OSST system (supported by ONR grants over the years) which performed extremely well. Both systems were placed on a platform which was suspended from the ship and moored on the bottom. Vertical profiles through a strong chlorophyll maximum allowed measurement of both the fine-scale Chl-a structure as well as the localization (to within cms) of acoustically reverberant scatterers. Results of image-processing of the OSST data indicate that it was able to image Chl-a concentrations over a.65 m x.65 m x 1 cm field of view with an approximate resolution of 1 cm^2 with exposure times as short as 50 msec. This allows almost

isotropic resolution of 1 cm over the field of view of the system. CTD and fluorometer data were also collected. The OSST data were consistent with the fluorometer results. However, the fact that the system produced approximately 10,000 estimates of Chl-a fluorescence, as a function of position, in contrast to the one (1) produced by the fluorometer gives us far more detailed view of the fine and microscale structure of the phytoplankton.

Scientific Results

The successful deployment of the instrument package has demonstrated that it is possible to measure the fine-scale and microscale distributions of phytoplankton and zooplankton in situ, over areas equivalent to typical organism's ambits. We have just (Sept. '95) begun to analyze the data and our first impressions are that the Chl-a structure is extremely patchy over very short spatial scales. Fluorescence emission appears to change by an order of magnitude over scales as short as centimeters. Moreover, the data indicate that the largest fraction of the Chl-a emission occurred from structures that were aggregated. Interesting questions about how these structures formed, whether in fact they can be maintained, and the strategies of herbivores foraging on it are under consideration.

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